Published in final edited form as:

Am J Health Behav. 2017 November 01; 41(6): 750–759. doi:10.5993/AJHB.41.6.9.

E-cigarette Use and Cigarette Smoking Cessation among Texas College Students

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Abstract

Objectives: We examined the relationships between e-cigarette use and subsequent cigarette smoking behaviors at 6- and 12-month follow-ups among young adults.

Methods: Participants were 18–29 year-old current and former cigarette smokers ($N = 627$) at 24 Texas colleges, participating in a 3-wave study. Multi-level, multivariable logistic regression models, accounting for school clustering, examined the impact of self-reported use of e-cigarettes on cigarette smoking status at 6- and 12-month follow-ups. Two mutually-exclusive groups of e-cigarette users were examined: those that used for cigarette smoking cessation and those that used for reasons other than cessation. Baseline covariates included socio-demographics, past quit attempts, nicotine dependence, cigarettes per day, and other tobacco use.

Results: Use of e-cigarettes for cigarette smoking cessation was associated with increased odds of cigarette smoking cessation at 6- and 12-month follow-ups, while using e-cigarettes for other reasons was not, when adjusting for covariates.

Conclusions: Use of e-cigarettes for cigarette smoking cessation may reduce cigarette smoking rates in young adult college students. Additional research is needed examining e-cigarettes as a complement to evidence-based cessation resources that are associated with cigarette smoking cessation among young adults.

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Human Subjects Statement

The University of Texas at Austin IRB [Protocol Number: 2013-06-0034] provided approval to conduct this research.

Conflict of Interest Disclosure Statement

No conflicts of interest to declare.

Keywords

e-cigarettes; cessation; young adults

Cigarette smoking cessation substantially reduces tobacco-related disease and mortality¹ and is a core component of comprehensive tobacco control.² Cessation during young adulthood (eg, 18–24 years old) is associated with long-term abstinence³ and cessation prior to the age of 35 can result in life expectancy similar to never smoking.⁴ Pharmacological medications (eg, Bupropion, Varenicline), nicotine replacement therapy (NRT) (ie, patch, gum, lozenge, nasal spray, inhaler), and behavioral interventions significantly increase smoking cessation rates,^{5,6} and the combination of these approaches is recognized as an evidence-based method of smoking cessation.² Electronic cigarettes (e-cigarettes) are not an evidence-based method of smoking cessation,⁷ although cigarette smoking cessation is one of the leading reasons for use among adults in general.^{8–11}

Although smoking cessation remains a commonly cited motivation for using e-cigarettes, young adults report varied reasons for using these products. In one study of adolescents and young adults, 41.8% of the sample reported they had used an e-cigarette to quit smoking.¹² However, some qualitative studies of young adults highlight other motivations, such as doing “smoke” tricks, experimenting with new technology, or trying flavors like cherry and bubble gum.^{13–15} To our knowledge, no previous studies have examined the differing impact of smoking cessation among young adults who are using e-cigarettes to quit smoking versus those who report using for other reasons.

Determining the impact of e-cigarette use on cigarette smoking cessation is a public health priority as smoking remains the leading cause of preventable death in the United States (US).¹⁶ Several studies and literature reviews cite e-cigarettes as an effective smoking cessation tool¹⁷ and promote these devices as a substitute for smoking.¹⁸ Additionally, one study found “long-term” e-cigarette users had greater odds of quitting conventional cigarettes, relative to those that did not use e-cigarettes.¹⁹ However, this study had a methodological limitation given the number of long-term e-cigarette users (N = 72) was small relative to the number of non-users (N = 1500). Thus, whereas studies have reported that e-cigarettes may be associated with cigarette smoking cessation, evidence remains inconclusive due to the low quality of the research published to date.⁷

Conversely, several clinical trials,^{20–22} population studies,^{23–25} and systematic reviews^{26,27} indicate e-cigarettes may be ineffective cessation devices and even lead to failed smoking cessation coupled with sustained e-cigarette use (ie, “dual use”). However, these studies restricted samples to current cigarette smokers, presenting methodological and theoretical limitations, particularly for longitudinal studies. Specifically, the exclusion of former smokers or successful quitters from the study sample resulted in the systematic exclusion of individuals with the outcome of interest (ie, cessation). If former cigarette smokers (ie, recent or long-term quitters) are excluded from observation, study samples are comprised of only those who have never attempted cessation or those who were unsuccessful in past quit attempts. By definition, this exclusion introduces possible selection bias.

In addition to the methodological limitations, cessation studies that include only current smokers also have theoretical limitations. As described in Stages of Change Theory,^{28–30} the behavioral outcome of cigarette smoking cessation extends beyond simply the initial act of quitting among current smokers but also includes sustained abstinence (or staying quit) among former smokers. As such, relapse among former smokers is a component of cessation,^{28–30} not an independent behavioral outcome. Studies that exclude former smokers from observation are, by definition, unable to observe the role of an exposure (eg, e-cigarettes) on short-term and sustained cigarette smoking cessation as well as smoking relapse.^{28–30} This exclusion of former smoker ultimately limits the interpretation and “real-world” application of study findings.

In addition to these methodological and theoretical limitations, it is likely that research on e-cigarette use for cessation cannot be conducted with a pre-determined systematic methodology given the lack of standardization among e-cigarette products that reduces the generalizability of findings across product types.⁷ Specifically, several factors related to product heterogeneity/customizability^{31–34} and behavioral use patterns (eg, frequency and strength of inhalation)^{35–37} cause substantial variance in nicotine delivery, which impacts user satisfaction and cessation outcomes.²⁷ Furthermore, until the implementation of the new Food and Drug Administration (FDA) deeming rule in 2016, there are not any regulatory requirements for e-cigarette nicotine concentrations, no quality control measures governing device manufacturing,³⁸ and there are no training or educational requirements for e-cigarette retailers. Given all these factors, evaluating the efficacy of e-cigarette use for cessation is more likely to be contingent on observing “real-world” e-cigarette use via observational studies,³⁹ such as the current study.

Study Aims and Hypotheses

In this study, we examine the relationships between e-cigarette use on subsequent cigarette smoking cessation in a cohort of 18–29 year-old college students at 6- and 12-month follow-ups. Specifically, we examine if college student current and former smokers’ use of e-cigarettes for: (1) cigarette smoking cessation, and (2) reasons other than cessation impact subsequent cigarette smoking. Little research has examined the impact of e-cigarette use on subsequent cigarette smoking cessation among young adults despite this age group having the greatest prevalence of e-cigarette use among adults.⁴⁰ Furthermore, no previous studies tease apart differences in motivations for using e-cigarettes when examining their role in cessation among young adults. To our knowledge, only one other study has examined similar associations among young adults, but was specific to Swiss males.¹⁰ The current study is the first to restrict the cohort to only current/former cigarette smokers rather than a general population, to include both males and females, and to be conducted in the US. Consistent with other research,^{7,39} we hypothesize that young adults who use e-cigarettes for cigarette smoking cessation will have a greater odds of cigarette smoking cessation at 6- and 12-month follow-ups relative to non-users of e-cigarettes. We further hypothesize that young adults who use e-cigarettes for reasons other than cessation will not have a greater odds of cigarette smoking cessation at 6- and 12-month follow-ups, relative to non-users of e-cigarettes.

METHODS

Study Design

This study is a longitudinal analysis of data collected from Waves 1–3, with approximately 6 months between each wave, of the Marketing and Promotions across Colleges in Texas Project (Project M-PACT), a rapid response surveillance study. Wave 1 data were collected from November 2014 to February 2015 from 5482 Texas college students. Wave 2 data were collected from May–June 2015 for 4326 of the original participants (79% response rate) and Wave 3 from October–November 2015 for 4321 of the original participants (79% response rate).

Participants.—Participants were college students attending 24 2- and 4-year institutions in 5 counties containing the 4 largest cities in Texas: Austin, Dallas/Fort Worth, Houston, and San Antonio. Eligibility criteria included being a full- or part-time, degree- or certificate-seeking undergraduate student attending a 2-year vocational/technical program, or a 4-year college/university. Participation was restricted to individuals between the ages of 18–29 years. However, individuals aged 26–29 were required to be lifetime tobacco users to be eligible for inclusion in the Project M-PACT cohort. This requirement was based on studies that revealed limited cigarette initiation after age 25.⁴⁴

For this study, only participants reporting a history of cigarette smoking at Wave 1, defined as having smoked 100 cigarettes in their lifetimes, were eligible (N = 1018). Among eligible participants, 391 were missing data at Wave 2 (ie, 6-month follow-up) and/or Wave 3 (12-month follow-up) and were removed from analyses. The final sample (N = 627) was comprised of 403 current cigarette smokers (64.3%) and 224 former cigarette smokers (35.7%).

Procedure.—Participants were recruited via email to participate in an online survey. Informed consent was given by eligible students. A \$10 e-gift card was given to each participant upon survey completion at Waves 1 and 2 and a \$20 e-gift card at Wave 3, and each participant was entered in a drawing to win one of 20 \$50 e-gift cards at all 3 waves. A total of 13,714 students were eligible to participate in the study and 5482 of these (40%) provided consent and completed the survey. The study design and procedures are detailed elsewhere.⁴⁵

Measures

Outcome variable.—The outcome variable for this study was cigarette smoking cessation at 6- and 12-month follow-ups (eg, Wave 2 and Wave 3). At each Wave, participants were asked: “Do you now smoke cigarettes?” with those reporting “everyday” or “someday” considered current cigarette smokers for each wave. Those that responded “not at all” were considered non-cigarette smokers (ie, quitters/abstainers).

E-cigarette use.—Study participants were categorized into 3 mutually-exclusive groups related to e-cigarette use. All participants were asked: “During the past 30 days, have you used any ENDS product (ie, an e-cigarette, vape pen, or e-hookah), even one or 2 puffs, as

intended (ie with nicotine cartridges and/or e-liquid/e-juice)?” Participants who did not report use of e-cigarettes in the past 30-days were considered non-users. For the purposes of these analyses, non-users served as the referent group (coded as 0).

Participants who reported using e-cigarettes in the past 30-days were subsequently asked: “Did you use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah) to try and quit cigarette smoking?” Participants who responded “no” were considered to have used e-cigarettes for reasons other than cigarette smoking cessation (coded as 1) and participants that responded “yes” were considered to have used e-cigarettes for the purposes of cessation (coded as 2).

Socio-demographic factors.—Based on previous research^{7, 27} several covariates were included to control for characteristics of cigarette smoking, and the covariates assessed at Wave 1 were included in analyses. Age ranged from 18 to 29 years old. Sex was a binary variable with males coded as 0 and females coded as 1. Race/ethnicity was re-coded into the following mutually-exclusive groups: white (referent group), Hispanic/Latino, African-American, Asian-American, and “other.” For the purposes of this analysis, “other” included American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, or any other race/ethnicity. Race/ethnicity was analyzed categorically. Institution type was dichotomized into 2-year college (referent) and 4-year college.

Tobacco use behaviors.—Participants were asked to report how many cigarettes they smoked per day at Wave 1. Number of cigarettes smoked per day was included as a covariate. Wave 1 use of other tobacco products was included as a covariate. Respondents that reported current (ie, past 30-day) use of hookah, smokeless tobacco, large cigars, little filtered cigars, or cigarillos were considered other tobacco users.

Cessation behaviors.—Past cigarette cessation attempts were assessed at Wave 1. Participants were asked: “During the past 12 months, how many times have you stopped smoking cigarettes for one day or longer in an attempt to quit?” Persons who reported having stopped smoking cigarettes for one day or longer, one or more times, in the past 12-months were considered to have made a past cigarette cessation attempt (coded as 1).⁴⁶ This covariate is particularly important given that a history of attempting to quit cigarette smoking serves as a proxy-measure of behavioral intentions/motivations. That is, intentions/motivations are the direct antecedent of behavioral actions (eg, quit attempt) towards a behavioral outcome (eg, cigarette smoking cessation), consistent with Stages of Change Theory.^{28–30}

Nicotine dependence symptoms.—Two symptoms of nicotine dependence were assessed at Wave 1, based on the Hooked on Nicotine Checklist (HONC).⁴⁶ First, participants were asked: “Have you ever had a strong craving to smoke a cigarette?” and responses were coded as 0=no/1=yes. Second, participants were asked: “Have you ever felt like you really needed a cigarette?” and responses were coded as 0=no/1=yes. A new single item was created ranging from 0 to 2, which summed the 2 previously described variables, consistent with previous research.⁴⁷

Attrition Analyses

We conducted t-test and chi-square analyses to determine whether participants with complete data who were included in the present study (N = 627) differed from those who were removed because of incomplete data (N = 391) on all Wave 1 variables. There were no differences in Wave 1 covariates between included and excluded cases. Similarly, there were no statistically significant differences in e-cigarette use behaviors (ie, use for other reasons, cessation use) between included and excluded cases.

Statistical Analyses

Prior to testing the study hypotheses, Wave 1 covariates were compared among those who used e-cigarettes for cessation (N = 116) and all other participants (N = 511) using chi-square and t-tests. Similarly, Wave 1 covariates were compared among former cigarette smokers (N = 224) and current cigarette smokers (N = 403) using the same tests. Additionally, chi-square tests were used to compare cigarette smoking prevalence at Wave 2 and Wave 3 by the 3 e-cigarette use categories of the full sample (N = 627), as well as stratified by current (N = 403) and former (N = 224) smokers.

Next, the study hypotheses were tested using multilevel, multivariable logistic regression models, which examined the associations between e-cigarette use behaviors (non-use, use for smoking cessation, and use for other reasons) at Wave 1 and cigarette smoking status at 6- and 12-month follow-ups (ie, Wave 2 and Wave 3), controlling for Wave 1 covariates. Multilevel analyses were conducted for all models to account for the nesting of participants within their Wave 1 college or university (ie, school was included as a random effect in multilevel models). All analyses were conducted using Stata 14.0 (College Station, TX).

RESULTS

Descriptive Statistics

Participants were 627 current and former cigarette smokers (57.3% female) attending 24 Texas colleges and universities; participants were 18–29 years old (mean age = 22.2; SD = 3.1) at Wave 1. The sample was 50.4% non-Hispanic white, 28.6% Hispanic/Latino, 3.2% African-American, 9.1% Asian-American, and 8.8% “other.” At Wave 1, 62.0% of the sample reported making a quit attempt in the past 12-months; 88.4% reported at least one symptom of nicotine dependence; and 41.2% used at least one other tobacco product. At Wave 1, 62.4% (N = 391) of the sample did not report use of e-cigarettes in the past 30-days, 19.1% (N = 120) reported use of e-cigarettes in the past 30-days for reasons other than cigarette smoking cessation, and 18.5% (N = 116) reported use of e-cigarettes for cigarette smoking cessation.

Tables 1 and 2 present the group comparisons (ie, chi square, t-test results) of Wave 1 socio-demographics. As Table 1 shows, participants who used e-cigarettes for cigarette smoking cessation differed from those who did not use e-cigarettes for cigarette smoking cessation by cigarettes smoked per day, age, symptoms of nicotine dependence, past cigarette cessation attempts, and other tobacco use. Table 2 shows that current cigarette smokers differed from

former cigarette smokers by age, race/ethnicity, sex, symptoms of nicotine dependence, past cigarette cessation attempts, and other tobacco use.

Table 3 presents cigarette smoking prevalence at Wave 1, Wave 2, Wave 3 by e-cigarette use status for the full sample (N = 627) as well as stratified by current (N = 403) and former (N = 224) cigarette smoking status, at Wave 1. Table 3 reveals that there were statistically significant differences in e-cigarette use category by cigarette smoking status at Wave 1, Wave 2, and Wave 3. No statistically significant differences were found among stratified samples, by e-cigarette use category.

Cigarette Smoking Cessation at 6- and 12-month Follow-ups

Table 4 shows that Wave 1 use of e-cigarettes for cessation was associated with increased odds of cigarette smoking cessation at 6-month follow-up, adjusting for covariates. Specifically, the use of e-cigarettes for cigarette smoking cessation increased the odds of cigarette cessation by a factor of 1.95 (95% CI: 1.16 – 3.28), at 6-month follow-up, relative to non-e-cigarette users

Table 4 shows that Wave 1 use of e-cigarettes for cessation was associated with increased odds of cigarette smoking cessation at 12-month follow-up, adjusting for covariates. Specifically, the use of e-cigarettes for cigarette smoking cessation increased odds of cigarette cessation by a factor of 1.66 (95% CI: 1.00 – 2.74), at 12-month follow-up, relative to non-e-cigarette users.

Table 4 also shows that there were no statistically significant differences in cigarette smoking cessation at 6-month (AOR: 0.72; 95% CI: 0.44 – 1.19) or at 12-month (AOR: 0.81; 95% CI: 0.50 – 1.30) follow-ups between non-e-cigarette users and those who used e-cigarettes for other reasons, adjusting for covariates.

DISCUSSION

This longitudinal study examines a cohort of young adults with a history of cigarette smoking, controlling for characteristics of cigarette smokers (ie, nicotine dependence, number of cigarettes smoked per day, past cessation attempts), while observing the effects of “real-world” e-cigarette use on smoking cessation. Findings revealed use of e-cigarettes for cigarette smoking cessation, relative to no e-cigarette use, was associated with greater odds of cigarette cessation in a cohort of young adult former and current smokers. Findings are consistent with cross-sectional³⁹ and longitudinal studies¹⁹ of e-cigarette use in the general population. Our findings are encouraging given the importance of cigarette cessation during young adulthood and the increasing acceptability of e-cigarettes among smokers. However, it should be noted that there is mounting evidence that young adult use of e-cigarettes, which may be less harmful than smoking combustible cigarettes, is not harmless. The Surgeon General⁴⁸ cites exposure to toxins in e-cigarette aerosol and nicotine exposure on the developing brain as harmful consequences of e-cigarette use in young adulthood.

Whereas our findings suggest e-cigarettes may play a role in increasing young adult cessation, these findings should be interpreted within the larger context of research on e-

cigarettes. One longitudinal analysis¹⁹ of cigarette smokers found e-cigarette use was associated with greater odds of cigarette smoking cessation but only among “long-term” users of e-cigarettes. Furthermore, a longitudinal study of e-cigarette use among young adults in Switzerland found that among non-smokers, baseline e-cigarette use was associated with greater odds of becoming a cigarette smoker at follow-up.¹⁰ Though both of these longitudinal studies had limitations, their findings suggest that e-cigarette use should *only* be advised as a possible aid in cigarette smoking cessation among former and current cigarette smokers, but discouraged among never smokers. Further, findings suggest the need for additional research on e-cigarettes as a compliment to evidence-based cessation resources (eg, quitlines, NRTs) that are associated with increases in young adult cessation.⁴⁹

Observational studies and randomized, controlled trials are needed to improve understanding of the impact of e-cigarette use on cigarette smoking behaviors. Whereas the motivations, expectations, and experiences of e-cigarette users have been examined qualitatively^{50,51} and quantitatively,¹² more observational studies are needed to provide additional characteristics of e-cigarette use associated with cessation. Specifically, public health research must remain up to date on the rapid development of e-cigarette devices, given the association between customizable options of e-cigarettes (eg, product design, battery-capacity, and nicotine concentrations/delivery) and both user satisfaction and cessation outcomes.²⁷ As e-cigarettes become more powerful and efficient delivery systems, the heterogeneity and customizability of these devices likely will necessitate product- and modification-specific randomized, controlled trials to validate the efficacy of each device as an aid to cessation, when combined with other components and e-liquids available on the market.

Study strengths include a large cohort of young adults who were longitudinally observed in 6-month intervals. Furthermore, this study controls for user characteristics such as socio-demographics, past cessation attempts, number of cigarettes smoked per day, and symptoms of nicotine dependence. Each of these variables is predictive of young adult cigarette smoking cessation.⁴⁹ Additionally, these covariates have been highlighted as lacking in existing e-cigarette literature.⁷ Another strength of this study is the inclusion of former cigarette smokers in the study sample. The inclusion of former cigarette smokers allowed this study to observe the non-linear nature of cigarette smoking cessation,^{28–30} including the initial attempt of quitting among current smokers as well as sustained cessation and/or relapse among former smokers.

Despite the aforementioned strengths, this study has some limitations. First, this research was unable to control for variations in e-cigarette product types (eg, disposable, refillable, etc.), nicotine concentrations, and use patterns, which may influence smoking cessation.²⁴ However, it is important to note the aim of this study was to evaluate the “real-world” efficacy of e-cigarettes when used for cigarette smoking cessation. To that end, our study intended to be representative of “real-world” e-cigarette use (ie, quality and variation of devices), rather than an assessment of the efficacy of particular e-cigarette products, nicotine concentrations, or use patterns. As such, this research design is inclusive of the heterogeneity of e-cigarette devices, nicotine concentrations, and use patterns by young adults. Second, our study is subject to self-selection bias inherent in population studies, limiting causal inferences. That is, use of e-cigarettes for cessation (or other reasons) was

self-selected rather than randomized. Third, this study relied entirely on self-reported data with no biochemical validation of cigarette use. As such, it is possible that participants under- or over-reported cigarette use. However, it should be noted that self-reported data are considered acceptable for population studies of cigarette smoking cessation.⁵² Finally, this study was specific to young adult college students in Texas and may not be generalizable to other populations. By using a convenience sample of young adult college students, this study is unable to speak to the broader population of cigarette smokers, as a whole. However, it should be noted that demographic characteristics of the study sample were like those of all enrolled students at the 24 participating colleges in fall 2014, with the exception of Asian Americans, who were over-represented in our sample, and African-American students who were under-represented. Given this limitation, we caution against applying findings to groups that are not proportionally represented in the college student population.

Conclusion

Although the presented findings are encouraging in terms of the potential efficacy of e-cigarettes and smoking cessation in young adults, it is important to note causal inferences cannot be made until the findings are replicated and/or there are randomized controlled trials to validate these findings. However, this study provides a basis for future public health research, programming, and policy, because it demonstrates that those who report using e-cigarettes for smoking cessation are more likely to quit smoking over time than those who do not use e-cigarettes. Further study is needed to determine the generalizability of the study findings as well as to gain better understanding of the role of behavioral support and other contributing factors on the efficacy of e-cigarettes as a cessation aid. Policy interventions are needed to: (1) ensure consumer protections and quality control of e-cigarette devices, particularly given the heterogeneity of the products;^{31–33} (2) regulate marketing messages used to promote e-cigarettes as cessation aids;^{41–43} and (3) limit unsubstantiated and potentially predatory e-cigarette marketing exposure among younger populations.^{53–55}

Acknowledgments

Research reported in this presentation was supported by grant number [1 P50 CA180906] from the National Cancer Institute and the FDA Center for Tobacco Products (CTP). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the Food and Drug Administration.

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Table 1
Descriptive Statistics for the Young Adult Sample by E-cigarette Use Status at Wave 1 (N = 627)

	Used E-cigarettes for Cessation at Wave 1 ^a (N = 116)	Did Not Use E-cigarettes for Cessation at Wave 1 (N = 511)	Statistical Analyses
Cigarette Smoking Status			$\chi^2(1, N = 627) = 0.91; p = .340$
Yes	68.1%	63.4%	
Wave 1 Cigarettes Smoked Per Day			$t(625) = -2.21; p = .014$
Number (if any) (mean, SD)	3.7 (4.8)	2.8 (4.0)	
Age (mean; SD)	21.7 (2.9)	22.3 (3.2)	$t(625) = 1.88; p = .031$
Race/Ethnicity			$\chi^2(4, N = 627) = 7.81; p = .099$
Non-Hispanic White	44.8%	51.7%	
Hispanic/Latino	31.9%	27.8%	
African-American	1.7%	3.5%	
Asian-American	14.7%	7.8%	
Other ^b	6.9%	9.2%	
Sex			$\chi^2(1, N = 627) = 2.38; p = .123$
Female	50.9%	58.7%	
Wave 1 Institution Type			$\chi^2(1, N = 627) = 1.16; p = .282$
Four-year College/University	92.2%	86.5%	
Wave 1 Symptoms of Nicotine Dependence^c (mean, SD)	1.87 (0.43)	1.57 (0.71)	$t(625) = -4.32; p < .001$
Wave 1 Past Cigarette Quit Attempt			$\chi^2(1, N = 627) = 49.0; p < .001$
Yes	90.5%	55.6%	
Wave 1 Other Tobacco Use			$\chi^2(1, N = 627) = 16.2; p < .001$
Yes	57.8%	37.4%	

Note.

Bold signifies statistically significant differences between those who used e-cigarettes for cessation and all other participants, $p < .05$

^aPast 30-day "use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah) to try and quit cigarette smoking?" at Wave 1

^b"Other" includes American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, or any other race/ethnicity

^cVariable ranged from 0–2. Two composite items were: "Have you ever had a strong craving to smoke a cigarette?" and "Have you ever felt like you really needed a cigarette?"

Table 2
Descriptive Statistics for the Young Adult Sample by Wave 1 Cigarette Smoking Status (N = 627)

	Current ^d Cigarette Smokers at Wave 1 (N = 403)	Former ^b Cigarette Smokers at Wave 1 (N = 224)	Statistical Analyses
Age (mean; SD)	21.7 (3.0)	23.0 (3.2)	t(625) = 5.0; p = <.001
Race/Ethnicity			$\chi^2(4, N = 627) = 13.5; p = .009$
Non-Hispanic White	45.7%	58.9%	
Hispanic/Latino	29.8%	26.3%	
African-American	4.2%	1.3%	
Asian-American	10.7%	6.3%	
Other ^c	9.7%	7.1%	
Sex			$\chi^2(1, N = 627) = 8.0; p = .005$
Female	64.7%	53.1%	
Wave 1 Institution Type			$\chi^2(1, N = 627) = 0.86; p = .353$
Four-year College/University	90.3%	87.9%	
Wave 1 Symptoms of Nicotine Dependence^d (mean, SD)	1.50 (0.78)	1.70 (0.62)	t(625) = -3.49; p = <.001
Wave 1 Past Cigarette Quit Attempt			$\chi^2(1, N = 627) = 42.0; p = <.040$
Yes	65.0%	56.7%	
Wave 1 Other Tobacco Use			$\chi^2(1, N = 627) = 24.4; p = <.001$
Yes	48.4%	28.1%	

Note.

Bold signifies statistically significant differences between current cigarette smokers and former cigarette smokers, $p < .05$

^a: Self-reported current use of cigarettes "everyday" or "someday"

^b: Self-reported current use of cigarettes "not at all"

^c: "Other" includes American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, or any other race/ethnicity

^d: Variable ranged from 0–2. Two composite items were: "Have you ever had a strong craving to smoke a cigarette?" and "Have you ever felt like you really needed a cigarette?"

Table 3

Cigarette Smoking Status at Wave 1, Wave 2 and Wave 3 by E-cigarette Use Status at Wave 1 (N = 627)

E-cigarette Status at Wave 1	Cigarette Smoker ^a at Wave 1	Cigarette Smoker ^a at Wave 2	Cigarette Smoker ^a at Wave 3
Full Sample (N = 627)	64.3%	54.9%	50.9%
Non- E-cigarette users ^b	58.8%	51.4%	48.1%
Used E-cigarettes, not for Cessation ^c	78.3%	66.7%	61.7%
Used E-cigarettes for Cessation ^d	68.1%	54.3%	49.1%
Statistical Analyses	$\chi^2(2, N = 627) = 16.13; p < .001$ $\chi^2(2, N = 627) = 8.65; p = .013$ $\chi^2(2, N = 627) = 6.95; p = .031$		
Wave 1 Current Smoker (N = 403)	N/A	73.7%	69.0%
Non-E-cigarette users ^b	N/A	74.8%	69.6%
Used E-cigarettes, not for Cessation ^c	N/A	77.7%	71.3%
Used E-cigarettes for Cessation ^d	N/A	65.8%	64.6%
Statistical Analyses	N/A	$\chi^2(2, N = 403) = 3.43; p = .180$ $\chi^2(2, N = 403) = 0.99; p = .609$	
Wave 1 Former Smoker^e (N = 224)	N/A	21.0%	18.3%
Non-E-cigarette users ^b	N/A	18.0%	17.4%
Used E-cigarettes, not for Cessation ^c	N/A	26.9%	26.9%
Used E-cigarettes for Cessation ^d	N/A	29.7%	16.2%
Statistical Analyses	N/A	$\chi^2(2, N = 224) = 3.18; p = .210$ $\chi^2(2, N = 224) = 1.49; p = .475$	

Note.

Bold signifies statistically significant differences between e-cigarette use categories, $p < .05$ ^aSelf-reported use of cigarettes “everyday” or “someday”^bDid not use e-cigarettes in the past 30-days^cPast 30-day “use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah)” but not “to try and quit cigarette smoking?” at Wave 1^dPast 30-day “use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah) to try and quit cigarette smoking?” at Wave 1

Table 4

Multilevel, Multivariable Models Predicting Cigarette Smoking Cessation at 6- and 12-month Follow-ups among Young Adults (N = 627)

Independent Variable: Wave 1 E-cigarette Use	Cigarette Smoking Cessation ^a 6-month Follow-up Adjusted Odds Ratio (95% Confidence Interval)	Cigarette Smoking Cessation ^a 12-month Follow-up Adjusted Odds Ratio (95% Confidence Interval)
Non-E-cigarette Users (Referent)	1.00 (Referent)	1.00 (Referent)
Used E-cigarettes, not for Cessation ^b	0.72 (0.44 – 1.19)	0.81 (0.50 – 1.30)
Used E-cigarettes for Cessation ^c	1.95* (1.16 – 3.28)	1.66* (1.00 – 2.74)
Baseline Covariates		
Cigarettes Smoked Per Day	0.74*** (0.68 – 0.80)	0.77*** (0.71 – 0.83)
Quit Attempt in Past 12-months	0.81 (0.54 – 1.21)	1.03 (0.70 – 1.53)
Age	1.07* (1.00 – 1.14)	1.09** (1.02 – 1.16)
Sex		
Male	1.00 (Referent)	1.00 (Referent)
Female	0.95 (0.64 – 1.39)	1.37 (0.96 – 2.00)
Race		
White (non-Hispanic)	1.00 (Referent)	1.00 (Referent)
Hispanic/Latino	0.58* (0.38 – 0.88)	0.87 (0.58 – 1.31)
African-American	0.25* (0.08 – 0.75)	0.50 (0.19 – 1.34)
Asian Ancestry	0.49* (0.26 – 0.95)	0.41** (0.22 – 0.78)
“Other” ^d	0.74 (0.37 – 1.47)	0.71 (0.36 – 1.37)
Institution Type		
4-year Institution	0.82 (0.44 – 1.53)	0.69 (0.38 – 1.27)

	Cigarette Smoking Cessation ^a (95% Confidence Interval)	Cigarette Smoking Cessation ^a Ratio (95% Confidence Interval)	12-month Follow-up Adjusted Odds Ratio (95% Confidence Interval)
Symptoms of Nicotine Dependence ^e	0.59 *** (0.44 – 0.79)	0.70 * (0.53 – 0.93)	
Past 30-day Other Tobacco Use	0.81 (0.54 – 1.21)	0.94 (0.64 – 1.38)	

= p < .001

**
= p < .01

*
= p < .05

Note.

All models accounted for the nesting of students within the 24 colleges.

^a: Those that responded they used cigarettes “not at all” were considered non-cigarette smokers (eg, quitters/abstainers).

^b: Past 30-day “use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah)” but not “to try and quit cigarette smoking?”

^c: Past 30-day “use any ENDS products (ie, e-cigarettes, vape pens, or e-hookah) to try and quit cigarette smoking?”

^d: “Other” includes American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, or any other race/ethnicity

^e: Variable ranged from 0–2. Two composite items were: “Have you ever had a strong craving to smoke a cigarette?” and “Have you ever felt like you really needed a cigarette?”